

ATTACHMENT
FOCUS GROUP STUDIES

Report on the Effects of Digital Cellphones on Hearing Aids

Submitted by:

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Description of Experiment Protocol

On July 12, 1995, in Washington, D.C., at approximately 2:00 P.M., an experiment was conducted in the presence of two unbiased observers to determine the effects, if any, of the use of digital cellphones on hearing aid wearers. The purpose of the experiment was to compare the effects of using two different technologies, TDMA (time division multiple access) as employed in GSM (global system mobile) and CDMA (code division multiple access), proposed for PCS (personal communication services) terminals with respect to interference to hearing aids. A total of 15 hearing aid wearers participated in the experiment and were asked to use cellphones which simulated the two technologies and respond to questions while using the phones. The researchers and observers were aware of which technology was incorporated into each cellphone, but the participants were not. An oscilloscope was used to demonstrate to the observers that each phone was functioning at normal levels as the experiment was conducted. The simulator was producing a power level of 200 milliwatts.

Two types of information were collected from each participant. First, each was asked to fill out a form responding to three questions. The participants were asked to indicate whether they wore hearing aids in one or both ears, to describe the nature of the hearing loss (no loss, mild, moderate, severe, or profound), and to identify the type of hearing aid(s) worn (behind the ear, in the ear, canal, body type, or other). After completing the form, each subject was brought into a room with the researchers and the observers and asked to sit down in a chair. Clear and consistent instructions were given individually, to each participant by the researcher in the presence of the observers. The

participant was instructed to place the first cellphone up to his or her ear in which a hearing aid was worn, as if making a call. For those with two hearing aids, the experiment was repeated in each ear, each time beginning with the right ear. The participant was then asked to report if there was any interference when the handset was placed against the ear and if so, to describe the nature of the interference. If interference was observed by the participant, then the same handset was returned to the researcher and the researcher held the handset at ear level to the participant and moved some distance away from the participant. The researcher then walked toward the participant and asked the participant to raise his hand when he or she first noticed the interference. This distance was recorded by the observers. Once again, the participant was asked to describe the interference in his or her own words. Finally, if only one hearing aid was worn, the first part of the experiment was repeated in the ear without hearing loss.

Results

Of the 15 participants tested, 11 reported wearing hearing aids in both ears, and 4 currently wore only one hearing aid, giving a total of 26 hearing aids to be tested. The experiment was performed using both the right and left ear for the 11 participants who wore hearing aids in both ears and using one ear for each of the remaining four participants. Hearing loss as reported by the participants ranged from mild to profound. The hearing loss in the 26 ears for which hearing aids were worn was reported to be mild in 1 case, moderate in 6 cases, moderate to severe in 2 cases, severe in 8 cases, severe to profound in 1 cases, and profound in 8 cases. The participants reported that 21 of the 26 hearing aids worn were behind-the-ear and 5 were in-the-ear.

Each of the 15 participants tested reported interference with the GSM technology. Ten of the 11 participants with two hearing aids reported interference in both ears and the 11th participant reported interference with the hearing aid worn in his right ear. This participant indicated that his hearing loss in the left ear was severe. Each of the four participants wearing one hearing aid reported interference with the GSM cellphone. Thus, of the 26 hearing aids tested, participants reported interference with 25 hearing aids. Fourteen out of 15 participants described the interference as a loud buzz or hum. Nine of the participants described the interference as annoying, irritating, or uncomfortable while 3 reported that the noise was so loud that they would be unable to talk or to hear. When asked to compare this interference with other types commonly experienced by hearing aid users, participants stated that it was not the same and it was louder and more significant. One participant predicted that prolonged exposure might cause headaches and another participant characterized the noise as painful. The intense nature of the participants' reactions was demonstrated by their eagerness to remove the handset from their ears when the researcher indicated they could do so.

In the second part of the experiment, conducted for participants who reported interference, the distance at which the noise was first noticeable was reported. This was tested for 25 of the hearing aids, since one participant reported no interference in one ear. The distances varied from right up against the ear to 59", with an average of 18.17" and a standard deviation of 16.46". Fourteen of 25 participants (56%) reported interference at a distance of 12" or more, 9 of 25 (36%) reported interference at 18" or more and 5 of 25 (20%) reported interference at 30". The average distance at which interference was

indicated was 21.31" for those wearing behind-the-ear devices and 1.35" for those wearing in-the-ear devices.

In the last part of the experiment, only one participant was eligible because he had non-impaired hearing in one ear, but wore a hearing aid in the other. (Although other participants wore hearing aids in only one ear, they had hearing loss in the other ear, but wore no hearing aid in the hearing-impaired ear.) This participant reported no interference in the ear without a hearing aid.

For the CDMA handset, no interference was reported by participants for 23 of the 26 hearing aids tested. Three participants reported interference when using the CDMA handset up against the ear. The noise was described as a low hum, noticeable, but not bothersome and one participant reported getting feedback. The distances at which this was first noticeable were 8", 9", and up against the ear.

Conclusions

The results clearly indicate that, for this group of participants, the frequency and severity of interference with hearing aids caused by GSM and CDMA are dramatically different. Interference from GSM cellphones was reported for 25 out of 26 hearing aids tested, and the nature of the interference was consistently reported as very annoying or disturbing to hearing aid wearers. Thus, it can be concluded that, if this group of users is typical of the population of hearing aid wearers, GSM cellphones will cause sufficient disruption to make this technology unacceptable for use by the nearly 5 million hearing aid wearers in the US. In addition, the results from examining the effects of the cellphones at a distance from the hearing aid wearers lead to the conclusion that these devices should not

be used in close quarters, like office environments. Only 3 hearing aid users reported a slight hum from the CDMA cellphones and none indicated that it was disruptive in any way, demonstrating that CDMA would provide acceptable service to hearing impaired users and could be used in any environment without significantly impacting the ability to hear.

A TEST FOR INTERFERENCE WITH HEARING AIDS BY DIGITAL TECHNOLOGY CELLULAR TELEPHONES

Observed and reported by David A. Shirley

ABSTRACT: *Fifteen hearing-aid users tested GSM and CDMA instruments for interference with their hearing aids. All found interference from the GSM instrument, while the CDMA instrument produced mild interference in only one case. The GSM instrument appears to be unusable by hearing aid wearers.*

THE SETTING: The tests were performed in the Presidential Suite (Room 1274) of the Capital Hilton Hotel in Washington, D.C. on July 9, 1995. Two observers were present. They prepared independent reports based on their observations.

THE PROTOCOL: Fifteen hearing-aid wearers tested the two instruments, which were turned on, were set at 200 milliwatts and were not identified to the users. Each hearing-aid wearer entered the testing room and went through the entire sequence of tests sequentially, using one instrument, then the other. In each case the GSM instrument was tested first, followed by the CDMA instrument. The subjects were asked to indicate the type of hearing aid(s) they were wearing (behind the ear or in the ear), and whether in the right or left ear, or in both. Each subject was then asked three questions, as applicable, about the effect of the handset on their ears.

In Question 1 (henceforth Q1), each subject was asked to hold the instrument up to the ear(s) with the hearing aid as if he/she were going to make a telephone call, and to report whether he/she heard anything. If so, they were asked to describe the sound.

In Question 2 (Q2), for the cases in which a sound was detected, the instrument was removed to a distance and then brought toward the subject's ear until the sound was again detected. The distance at which sound was first heard was recorded.

Finally, for Question 3 (Q3), if applicable, the handset was placed against the ear that had no hearing aid, and the subject was asked to report interference with the hearing aid on the other ear.

RESULTS: Three of the fifteen subjects wore in-the-ear and twelve wore behind-the-ear hearing aids. In the first group two wore hearing aids in both ears and one on only one. In the second group nine wore hearing aids in both ears and three in only one. Thus there were, for each handset, a total of 26 answers to Q1, the "Yes/No" answers to Q1 were:

GSM:	25 Yes	1 No
CDMA:	2 Yes	24 No

Both the single "No" answer for the GSM handset and the two "Yes" answers for the CDMA handset were highly qualified. In the former, the subject volunteered that he had a profound hearing loss in that ear alone, and the loss may have been total. In the latter case, the interference was characterized as "much, much lower in volume than with the other instrument, and not serious, though higher in pitch".

The volunteers' descriptions of the interference with the GSM handsets follow. All are direct quotes:

FOR IN-THE-EAR HEARING AIDS:

"Faint steady hum"

[nothing: see above]

"Annoying hum like static"

"Persistent, irritating low hum"

"Persistent, irritating medium hum"

FOR BEHIND-THE-EAR HEARING AIDS:

"Extremely loud: unusable"

"Hum: not as loud"

"Buzz and pulsating sound: disruptive, unusable"

"Painful"

"Real[ly] loud buzzing"

"Even worse...could be painful"

"Very annoying: clickity clack: disturbing"

"...metallic clacking: very annoying"

"...buzzing, ...like a bee in your ear: very disturbing"

"terrible" [winced]

"noise: buzzing, humming"

"very significant buzz"

"very loud"

"...very annoying, disruptive"

"uncomfortable: loud..."

"wouldn't use it"

"...annoying hum"

"[would be] impossible to understand speech on the phone"

"...loud, annoying..."

"really uncomfortable.." [winced at a distance]

The answers to Q2 were conditional on the answers to Q1. For the in-the-ear hearing aids, the distances at which interference was picked up ranged from 0 inches to 3.5 inches, with the average being about 1.5 inches, using the GSM handset. With the CDMA handset, a slight humming was perceived in one case, when the handset was held against the ear, and nothing in the other four cases.

The twelve subjects with behind-the-ear hearing aids picked up interference at larger distances in every case; namely at distances of 5,5,6,7,9,10,11,12,13,14,15,15,19,26,28,29, 32,35,42,57 and 59 inches, for the twenty-one cases (nine subjects with both ears, and three with one ear, equipped with a hearing aid). As noted above, the one subject with profound hearing loss who detected a slight high-pitched interference from the CDMA handset found it at 8 inches for one ear and 9 inches for the other.

Regarding Q3, of the four subjects with hearing aids in only one ear, all found no interference when the GSM headset was placed against the other ear.

CONCLUSIONS: Two conclusions emerge readily from these tests:

1. Under these conditions, the GSM handset is unusable by hearing-aid wearers. For behind-the-ear hearing aids the range of interference is large enough to cause interference by another person using the handset very close.
2. In contrast, the CDMA handset generally does not create interference, and it can be used by a hearing-aid-user.

CERTIFICATE OF SERVICE

I, Tiffany D. Scott, a secretary at Baker & Hostetler, hereby certify that on August 1, 1995, a copy of the foregoing Reply Comments were delivered to each of the following via First Class Mail, postage prepaid:

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